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Parasitological Evaluation of a Foodhandler Population Cohort in Panama: Risk Factors for Intestinal Parasitism.

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A nonconcurrent, prospective intestinal parasitic disease study in a group of 200 foodhandlers employed in the Panama Canal Area was conducted in mid-1985 as part of an established occupational health medical surveillance program. The study included a review of laboratory testing (i.e., coprological exam), preexisting medical record data, and patient interview information to calculate estimates of incidence and risk factors associated with acquisition of *Giardia lamblia* and other protozoan/helminthic intestinal parasites. Significant increases in risk of infection were detected for specific native Indian and West Indian employee groups when compared with their Hispanic Panamanian (i.e., Latinos) or North American (i.e., U.S. born) counterparts. A three- to fourfold higher rate of infection was also documented during a one-year period when semiannual rather than annual examinations were conducted. No difference in the therapeutic efficacy of parasitological cure of Metronidazole versus Quinacrine was found when used in the treatment of individuals with asymptomatic *G. lamblia* infections (85% in both groups). The appropriateness of mass therapy of asymptomatically infected foodhandlers is discussed.

Introduction

Parasitic diseases have long been a concern for military forces stationed or conducting operations in overseas areas. This threat is increased when operating in tropical regions of the world, as clearly illustrated by the experience of U.S. military units in the Pacific Campaign of World War II and the Vietnam Conflict.[1,2] In more recent times outbreaks of hookworm[3] and leishmaniasis[4] have been associated with training of our military forces at the Jungle Operations Training Center (JOTC), Fort Sherman, Panama as well as during the invasion of Grenada in October of 1983. Some of the more common intestinal parasitic infections prevalent in many developing countries pose a significant threat to American troops and/or their families stationed overseas. As an illustration, it is estimated that the pathogen *Giardia lamblia* was responsible for most of the cases of diarrhea requiring hospitalization of American military personnel in Vietnam.[5] In this study we describe one such threat, foodhandlers asymptomatically infected with *G. lamblia* and other protozoan/helminthic enteropathogens and suggest procedures for their medical screening, prevention, and treatment.

Study Objectives

The primary purpose of our study was to better define and characterize epidemiologically the extent and type of intestinal parasitic (helminthic and protozoan) infections in a predominantly native Indian, low socioeconomic level group that serves as a source of employees for dining facility, club, day care, and mobile food service operations in the Panama Canal Area. The group included 200 food service and day care personnel who serve a population of around 3,000 active duty soldiers and their dependents stationed within military installations located on the Atlantic side of the Panama Canal Isthmus (about 50 miles northwest of Panama City).

A secondary objective was to determine the efficacy of the two principal modes of treatment employed by the occupational health program staff in controlling *G. lamblia* infections in these employees. Generally accepted treatment modalities for clinically overt infections at the time included 5-day regimens of Metronidazole, 250 mg three times/day or Quinacrine, 100 mg three times/day.[6] Response to these two therapeutic regimes in subclinically infected personnel was to be examined in some detail to determine the optimal, most effective treatment for local use.

Study Materials and Methods

The study was designed as a nonconcurrent, prospective cohort follow-up based primarily on information contained in the subjects' medical health surveillance files maintained by the Occupational Health Section staff at the Coco Solo Army Health Clinic (CSAHC). This clinic is under the operational control of the Gorgas U.S. Army Community Hospital (GACH) located in Panama City. It provides all emergency and outpatient services to U.S. citizens on the Atlantic side of the isthmus. Medical surveillance records for the period from January 1977 through July 1985 were available for review. All available employees (196 out of 200) were brought in during a 3-month period in 1985 and were administered a questionnaire containing demographic data, worksite location, job category, length of employment, and any past evidence of gastrointestinal

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TABLE I

BREAKDOWN OF STUDY POPULATION BY SEX, ETHNIC GROUP, AGE, OCCUPATIONAL TYPE, AND TRANSMISSION RISK GROUPS

Variable	Number of Individuals	Percentage of Population
Sex		
Male	135	69%
Female	61	31%
Ethnic group		
Kuna Indian	104	53%
West Indian	50	26%
Latino	24	12%
North American	18	9%
Age (in years)		
<20	6	3%
20–29	24	12%
30–39	59	30%
40–49	68	35%
50–59	35	18%
>59	4	2%
Occupational type		
Mess hall attendant	89	46%
Daycare center attendant	28	14%
Waitress/waiter	21	11%
Cook	13	7%
Food vendor	11	6%
Meat cutter	7	4%
Food storage clerk	6	3%
Supervisor/other	20	10%
Unknown	1	-
Transmission risk groups		
High risk	120	62%
Low risk	75	38%
Unknown	1	-

TABLE II

OVA/PARASITE EXAM AND CULTURE RESULTS IN STUDY POPULATION

Infectious Agent	Number of Infections[a]	Percentage of Infections	Persons Infected[a]	Percentage Infected
Giardia lamblia	63	46%	49	25%
Entamoeba coli	21	15%	19	10%
Ascaris lumbricoides	19	14%	17	9%
Trichuris trichiura	11	8%	9	5%
Endolimax nana	8	6%	8	4%
Iodamoeba butschli	5	4%	5	3%
Hookworm spp.	4	3%	4	2%
Salmonella spp.	3	2%	3	2%
S. stercoralis	1	1%	1	1%
C. mesnili	1	1%	1	1%
Total	136	100%	80	41%

[a] 80 out of 196 individuals infected a total of 136 times.

symptoms while on the job. Additional sources of patient data included: a) recorded coprological specimen testing results in the CSAHC Microbiology Section (kept for the period January 1982 through July 1985); b) interviews with the treating physician/nurse at the clinic; and c) existing outpatient/inpatient treatment records for those persons eligible for care at CSAHC (mainly U.S. civilian employees).

Methods used in conducting microbiological examination of stool specimens were reviewed. Microscopic examination for intestinal parasites was done with wet mount of fresh feces technique using saline (0.85%) and iodine solution (1:5 dilution of Lugol's iodine). To increase the rate of recovery of parasites, a concentration procedure was also performed routinely using the zinc sulfate centrifugation and flotation technique of Faust.[7] Stool cultures were performed routinely on initial employment of all subjects. Annual medical and coprological follow-up was subsequently undertaken based on clinical findings and preexisting Department of the Army and Department of Defense promulgated guidelines.[8,9] End-of-study stool specimens were collected on all 196 employees available at the time of interview (July-September 1985). A parasitological cure was assumed if the follow-up post-treatment stool examination (done within 1 month) was found to be negative for the specified pathogen. No additional, periodic (weekly or monthly) stool evaluations were conducted thereafter unless as part of routine annual or semiannual screenings.

Information was automated by use of a data coding sheet and subsequent input into a VAX/VMS 8620 minicomputer system available at the Walter Reed Army Institute of Research (WRAIR). Epidemiological analyses were conducted by use of the Statistical Analysis Software (SAS) and included descriptive, univariate, and multivariate analysis using a linear regression model in predicting *G. lamblia* and other parasitic infections.[10] Estimation of attack rates, relative risks of infection, and associated confidence limits were performed as described elsewhere.[11] All statistical tests (chi-square comparisons; relative risk determinations and associated confidence limits; *t*-tests of difference between means; and *t* statistics for multiple linear regression) assumed a level of significance of 5%.

Study Results

A total of 196 individuals were included in the study. They constituted 98% of the total population of 200 at the end of the study in September 1985. Sex, age, and racial breakdown are shown in Table I. Predominantly middle-aged men of native Indian (i.e., Kuna) or Black, West Indian (mainly Jamaican) descent were followed. Less than 10% of the study group was composed of persons of caucasian origin (i.e., North Americans). Table I also illustrates the breakdown by job categories (occupational types) and perceived risk of transmission (i.e., high vs. low) as judged by the amount of time in direct contact with, and the extent of manual handling of food items and drinks. Almost two-thirds (62%) of individuals fell into a job category that would be considered of a high risk to persons they served. These categories included mess hall attendants, cooks, meat cutters, and food vendors.

The distribution of total follow-up time in the study exhibited a bimodal distribution with 28 personnel (14%) followed for 2 years or less and an additional 45 individuals (23%) followed for 7 years or longer. Eighty out of the 196 persons studied (41%) were found to be infected with one or more protozoal/helminthic enteropathogens a total of 136 different times during the study period (Table II). The most common intestinal pathogen found was *G. lamblia*; this accounted for 46% of all documented infections involving 25% of all person-

TABLE III

ATTACK RATES (AR) AND RELATIVE RISKS (RR) OF INTESTINAL PARASITISM AND *GIARDIA LAMBLIA* CARRIAGE BY SEX, ETHNIC GROUP AND TRANSMISSION RISK GROUP

Variable	Number of Individuals	Number Infected	AR	RR (95% CI)
Intestinal parasitism				
Sex				
Male	135	67	50%*	2.33 (1.40–3.88)
Female	61	13	21%	1
Ethnic group				
Kuna Indian	104	59	57%*	5.11 (1.37–19.06)
West Indian	50	14	28%	2.52 (0.63–10.02)
Latino	24	5	21%	1.88 (0.41–8.59)
North American	18	2	11%	1
Transmission risk group				
High risk	120	63	53%*	2.35 (1.49–3.69)
Low risk	76	17	22%	1
Giardia lamblia carriage				
Sex				
Male	135	43	32%*	3.24 (1.46–7.20)
Female	61	6	10%	1
Ethnic group				
Kuna Indian	104	38	37%*	6.58 (0.96–44.93)
West Indian	50	91	8%	3.24 (0.44–23.81)
Latino	24	1	4%	0.75 (0.05–11.20)
North American	18	1	6%	1
Transmission risk group				
High risk	120	39	33%*	2.47 (1.31–4.65)
Low risk	76	10	13%	1

* Statistically significant difference at $p < 0.05$ level.

nel. Other commonly found enteropathogens included roundworms (*Ascaris lumbricoides, Trichuris trichiura,* hookworm, *Strongyloides stercoralis)* and intestinal protozoa *(Entamoeba coli, Endolimax nana, Iodamoeba butschlii,* and *Chilomastix mesnili.*)

The effect that age, sex, race, occupational group, and time in occupation had on parasitism and giardia carriage rates was evaluated (Table III). Higher relative risks were associated with males belonging to an Indian subculture and working in a high risk occupational group. When all high risk variables were analyzed in a multivariate linear regression model, however, only racial background was still found to be significantly correlated with the development of a parasite infection (especially *G. lamblia*) (Table IV). No information was available on other potentially confounding risk factors such as family size, type of housing, presence or absence of indoor plumbing, pets in the household, or number of small children in the family.

Incidence-density rates (per person-year) by time in occupation were calculated to give the investigators an estimate of the efficacy of increasing screening frequency in detecting prior undocumented infections (Fig. 1). Implementation of a semiannual screening program in the summer of 1984 more than tripled the estimated annual incidence of infection when compared with the baseline annual screening in existence prior to 1984. In order to be sure that such an increase in detection during the 1984–85 period was not due to enhanced knowledge/awareness on the part of the laboratory technicians at CSAHC, a 2-week quality control survey was conducted in July 1985. Duplicates of unlabeled (i.e., blinded) stool samples from

TABLE IV

MULTIPLE LINEAR REGRESSION OF PARASITIC INFECTION AND *GIARDIA LAMBLIA* CARRIAGE ON AGE, SEX, ETHNIC GROUP, AND TIME IN OCCUPATION (TOC)

Variable	Coefficient	SE of estimate	t-statistic	p
Dependent (predicted) variable: parasitic infection				
Constant	+0.06	0.27	+0.22	NS
Age	+0.003	0.007	−0.44	NS
Sex	+0.12	0.18	+0.70	NS
Ethnic group	+0.30	0.09	+3.10	<0.01
TOC	−0.001	0.002	−0.45	NS
Dependent variable: *Giardia lamblia* carriage				
Constant	+0.02	0.20	+0.12	NS
Age	−0.003	0.005	−0.52	NS
Sex	+0.07	0.13	+0.58	NS
Ethnic group	+0.20	0.07	+3.00	<0.01
TOC	−0.002	0.002	−0.93	NS

foodhandlers were submitted jointly to the Microbiology Sections at GACH and CSAHC. Close agreement between both labs was found after testing 39 separate specimens; 75% of positive control samples (i.e., 3 of 4) and 100% of negative specimens (i.e., 35 of 35) were correctly identified by both groups. Thus, interobserver variation in technique or interpretation did not seem to account for the increased detection found during the later part of 1984 and early part of 1985.

Of *G. lamblia* infected patients, 26% (13 of 49) were found

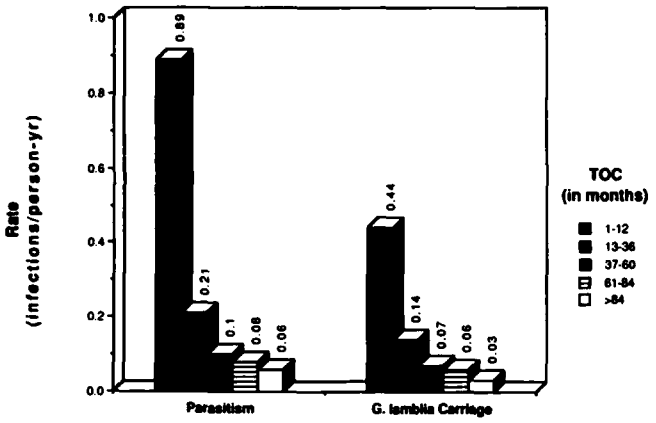

Fig. 1. Incidence density rates (per person-year) by time in occupation.

to have multiple infections. Similarly, 38% (30 of 80) of infected persons had two or more different gastrointestinal parasitic infections throughout the 8-year study period. Kuna Indians accounted for 92% and 87%, respectively, of multiple infections with *G. Lamblia* and other gastrointestinal parasites. In order to address the second objective of this study, the parasitological cure rates (i.e., clearance of infection) of *G. lamblia* by mode of therapy and number of treatment episodes was evaluated. Metronidazole and Quinacrine were equally efficacious in eliminating the carrier state in approximately 85% of such patients (38 of 45 patients responded to Metronidazole versus 11 of 13 responders to Quinacrine). Response to initial treatment with a single drug was found to be associated with higher parasitological cure rates. Daily administration for 5 days, as previously recommended,[6] was seen to be 96% efficacious (46 of 48 patients cleared of infection) compared with a 60% response (3 of 5) for those patients needing two or more consecutive treatment regimens.

Discussion

Giardia lamblia has been recognized for approximately 30 years as being an intestinal pathogen of major importance in the United States and abroad.[12] It is estimated to infect between 2% and 25% of the world's population, making it one of the most common parasites of mankind.[13] Reports of major outbreaks in North Americans returning from Leningrad[14] as well as in specific population groups routinely exposed to contaminated drinking water sources[15] have served to increase the awareness of such infections by health care providers as well as increase our body of knowledge regarding the geographical distribution and risk factors associated with disease. Past population-wide surveys by the Centers for Disease Control (CDC) in the United States have pointed to *G. lamblia* as the major intestinal pathogen isolated from native Americans, with overall infection rates of up to 17% in certain regions of the country[16] and accounting for as many as 30% of waterborne disease outbreaks reported to the CDC in the past.[17] Studies of Mexican female immigrants, as well as unpublished studies conducted in rural Bangladesh, moreover, have documented an even higher rate of infection in populations in which there is already a higher incidence of infection, as reflected by a high prevalence of serum and milk antibodies.[18] Fewer data are available, however, from Panama or other countries in Central or South America, although at least one report identifies this pathogen as significant among Guatemalan Indian children[19] and Brazilian natives.[20]

The relative significance of our study findings is highlighted by the fact that all infected personnel were members of a potentially high risk group of foodhandlers who could serve to amplify the transmission of this parasite similarly to that seen in at least one previously reported foodborne outbreak of giardiasis.[21] The fact that none of these infections were manifested clinically and went, for the most part, undetected for prolonged periods of time raises the question of appropriateness of screening for this parasite in similar populations of food service workers elsewhere. Deficient personal hygiene habits coupled with a lack of adequate water filtration and sewage disposal undoubtedly lead to cross-contamination of food items and spread of these and other intestinal pathogens among the Kuna Indians in this study. This same situation would be expected in similar native population groups in other countries where high prevalences of parasitic intestinal infections have been documented.[19,22] It is not known what role, if any, genetic or familial factors may play in increasing the susceptibility to such infections in inbred groups such as the Kunas.

Overall, almost two thirds of the population studied worked daily in job positions where contact and handling of food items presented a risk to clientele attending snack bars, cafeterias, dining facilities, and other similar establishments in operation in the Panama Canal Area. Although no foodborne or waterborne outbreaks of parasitic disease have been reported in this region recently, at least two previously identified foodborne outbreaks of hepatitis A and shigellosis have taken place in the past 6 years (Hernandez-Fragoso, I., and Sanchez, J.L., unpublished data). It is possible that additional infections or frank outbreaks of disease have gone undetected or that, alternately and more likely, the risk of food-derived transmission of *G. lamblia* and/or other intestinal parasites is so low that there is no real problem. Additionally, the clinical presentation of most of the infections described herein was of a chronic nature, with very nonspecific signs/symptoms and rather long incubation periods of weeks to months making detection of isolated cases or clusters rather difficult.[23] The lack of clinically-overt illness by study subjects is most likely because of an already existing high level of immunity due to frequent, repeat infections in long-term residents of highly endemic areas.[24] In our study, this latter explanation seems to be a plausible one since 26% and 38% of *G. lamblia* and other intestinal parasitic infections, respectively, were found to be multiple in type.

The magnitude of the increased relative risk of infection (3 to 6 times higher in Kuna and West Indians) seen here is one of practical importance since these two ethnic groups account for approximately 80% of the foodhandlers employed in food service and daycare facilities in the Canal Zone. This increase in risk was found to be "statistically true" on univariate as well as multivariate analyses. Increasing the frequency of coprological screening from annually to semiannually with a concomitant three- to fourfold increase in detection of carrier states is

an important finding that, to our knowledge, has not been adequately evaluated. We do not feel that the increased rate of detection could have been due to a transient state of epidemic transmission at the time semiannual screenings were being implemented, since more than one parasite species was involved and no clinically-overt cases occurred during this same time period. It should be pointed out also that the detected rates may, in turn, be as much as half the real rates since it is well known that single coprological screening for *G. lamblia* without further direct exam of small intestinal fluid or direct biopsy may pick up only 40% to 50% of infected, symptomatic patients (and even a lesser proportion of infected carriers).[25]

In terms of treatment of carriers it is unclear that repeated use of chemotherapeutic regimens may be necessary, since our parasitological cure rate using either Metronidazole or Quinacrine was not optimal and the risk of transmission to clients of infected food service workers may be insignificantly small in comparison to the side effects of such treatment. Why only 85% of initially infected individuals responded to treatment is unclear. It may be explained by the chronicity of such infections and/or reexposures, leading to a low-level of intestinal infection that may be difficult to eradicate. It became apparent also that individuals failing to respond to initial treatment often failed on a second treatment attempt. Given these findings, and taking into consideration the lack of adequate data on the carcinogenicity and mutagenicity of Metronidazole[26] versus the common side effects and lack of compliance record of Quinacrine, it is evident that further studies of these and other alternative agents are warranted. For now, it is apparent to us that if a decision is made to treat, Quinacrine should be used as the first-line drug followed by subsequent courses of Metronidazole or Quinacrine in individuals who fail to respond initially. In the future, other therapeutic agents, such as tinidazole[20] or mebendazole[27] may become available for treatment of this condition. The lack of an adequate chemoprophylactic, preventive modality is also a clear shortcoming when dealing with *G. lamblia*. It is doubtful that routine, periodic use of antihelminthic medications in a group with a high prevalence of infection is going to be of any significant additional benefit given repeated exposures and the need for frequent dosing on a mass scale before a significant decrease in the baseline parasitism rate is attained.[19,28]

Clearly, the need for basic public health education and correction of sanitation problems in highly endemic groups like the one in this study is an absolute requirement. Previous parasitic stool surveys in different areas of the world have definitively shown the relative importance of *G. lamblia* as a human pathogen within social groups in which substandard hygienic practices are universal.[25] It is likely that predisposing factors such as handwashing practices, lack of disinfection of drinking water, use of potentially contaminated water sources (such as river/stream water) for cooking purposes, and the lack of latrine/human waste disposal facilities or indoor plumbing play an important role in predisposing to acute or chronic infections.[28]

Conclusions

The following are the major conclusions derived from this study:

a. Parasitic gastrointestinal pathogens, in particular *G. lamblia*, are a common cause of infection among selected Kuna Indian and West Indian population groups in Panama.

b. The role that periodic, routine mass chemotherapy may have in decreasing the extent or duration of *G. lamblia* infection in this population is unknown but is not considered to be practically, medically, or ethically indicated. This position has been well expresed by other authors.[19,22]

c. No difference in therapeutic efficacy of parasitological cure of Metronidazole versus Quinacrine was found in the management of individuals asymptomatically infected with *G. lamblia* after using widely recommended dose regimens. The response in terms of clearance of infection was significant, but not optimal (i.e., around 85%). Quinacrine seems to be the drug of choice when concerns about carcinogenicity, mutagenicity, side effects, and lack of compliance are taken into consideration.

d. Education on proper hygiene and foodhandling practices would seem to be of paramount importance and should always be emphasized on an individual patient basis at the time of periodic screening. In the long run any educational program has to be accompanied by larger community measures such as improvement of the water supply and sewage disposal before an effective control is attained.

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